Use of NEMS For EERE Policy Analysis

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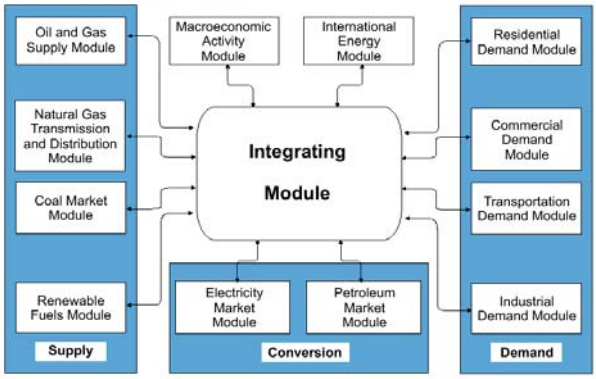
Today's Discussion

- Brief overview of the National Energy Modeling System (NEMS)
- Use of NEMS by EERE for estimating program benefits
- Modeling enhancements for wind class representation and offshore wind
- Enhancements to distributed PV representation
- Extension to 2050
- Other NEMS policy analysis capabilities

NEMS Overview

- NEMS was built by EIA for creating its mid-term energy projections and for policy analyses.
- NEMS has a modular design organized by energy producing, consuming, and conversion sectors.



Key Features of NEMS

- Annual simulation model to 2025
- Optimization techniques used for electricity capacity expansion and dispatch and petroleum refining
- Regional energy markets – Census Divisions, NERC electricity regions, PADD regions, etc.
- Technology representation in most sectors of interest to EERE – residential, commercial, and transportation demand sectors, industrial heat and power, electricity supply and renewable energy

Use of NEMS for GPRA Benefits

- EERE uses NEMS and other tools to measure the benefits of its programs as part of their Government Performance and Results Act (GPRA) reporting
- NEMS provides a consistent economic framework
- Important for determining individual program and portfolio benefits
  - Programs may target similar markets and therefore interact
  - Energy efficiency and renewable energy deployment can lead to energy price reductions that in turn dampen the cost-effectiveness of the EERE technologies
- Alternative scenarios will be used this year to look at options value of EERE's R&D portfolio

GPRA Integrated Modeling Process

- The first step is the development of a Base Case
  - Most recent AEO modified to remove identifiable program impacts already included by EIA
    - For example, Million Solar Roof PV installations
  - Selected model enhancements made to better represent program target markets
- Representation of each of the 11 EERE programs
  - The goals for each program are represented within NEMS-GPRA to assess the benefits of their achievement
- Portfolio Case
  - All the programs are combined in a single case
  - Integrated impacts of Portfolio case are not equal to the sum of the individual programs due to interactions and feedbacks

NEMS Enhancements

- Commercial building shell index replaced with economic evaluation of individual efficiency measures (windows, insulation, etc.)
- Distributed generation modifications to improve stock accounting
- Wind module replaced with one that has more detail by wind class
- Input and output displays for ease of use

Representation of R&D Programs

- R&D programs goals generally are represented by changing technology cost and performance characteristics.
  - Examples include: wind turbines, heat pump water heaters, hybrid vehicles
- In some cases analysis must be done off-line either due to insufficient technology information or lack of NEMS-GPRA detail
  - Site energy savings are then input into the model
  - Examples include: Most of the industrial sector R&D programs (Industries of the Future)

Representation of Standards

- Appliance standards are represented by eliminating availability of less efficient technologies in years after the standard implemented
- Residential building codes can be represented by eliminating less efficient shell packages, but codes have different levels of compliance and stringency by State.
  - For GPRA we rely on an offline analysis of the average heating and cooling savings and adoption rates
- Commercial building codes can be represented by requiring a minimum level of efficiency from the combination of shell measures

Representation of Deployment Activities

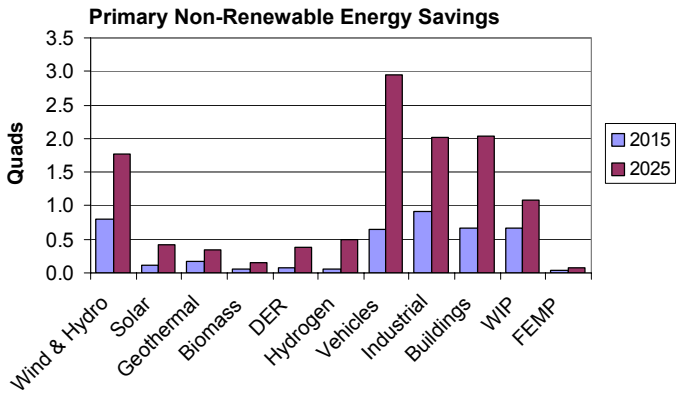
- Deployment programs often have adoption rate goals
- The Energy Star program is represented by lowering consumer hurdle rates for end uses targeted by the program to achieve the program adoption goals
  - Examples include residential lighting, refrigerators and water heaters.
- Weatherization savings estimated offline based on expected budget levels and past performance are implemented by reducing heating and cooling demands in residential buildings
- Industrial Best Practices savings are estimated offline and are subtracted from industrial energy demands

EERE Program Benefits

- GPRA Metrics include
  - Non-renewable energy savings
  - Energy expenditures
  - Carbon emission reductions
  - Oil savings
  - Natural gas savings
  - EERE technology capacity and generation or displaced central station capacity
- Benefits are reported at the program level and for the Portfolio as a whole.

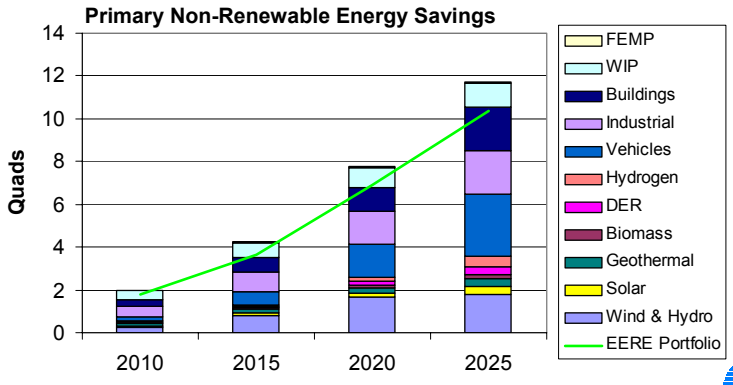
FY05 Program Energy Savings

- Magnitude and timing of program savings vary significantly due to differing types and scope of activities.



FY05 Program and Portfolio Benefits

- By 2025, the EERE Portfolio is projected to decrease primary non-renewable energy by 10.4 quads, which represents 31 percent of the projected growth in energy demand from 2005.



Wind Module Enhancements

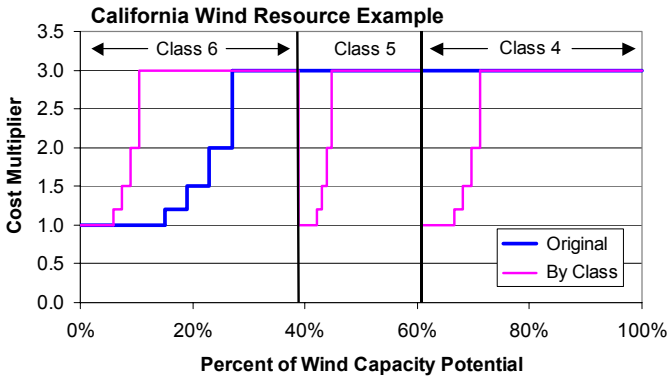
- Further detail added to NEMS regarding wind resources
  - Allows resource characterization (cost multipliers) to vary by wind class to accommodate
    - Different interconnection costs
    - Class 4 winds closer to load
  - Allows representation of low-wind speed turbine technology cost differences
- Offshore wind capability added

Wind Resources Representation in NEMS

- NEMS represents 3 wind classes within each region
- Currently each region's wind resource is characterized by 5 cost steps, independent of wind class
  - Higher class wind class sites assumed to be used first
- In modified version, resource multipliers (5 cost steps) applied by wind class, instead of for the regional resource as a whole
- Competition performed to determine lowest cost wind class each year

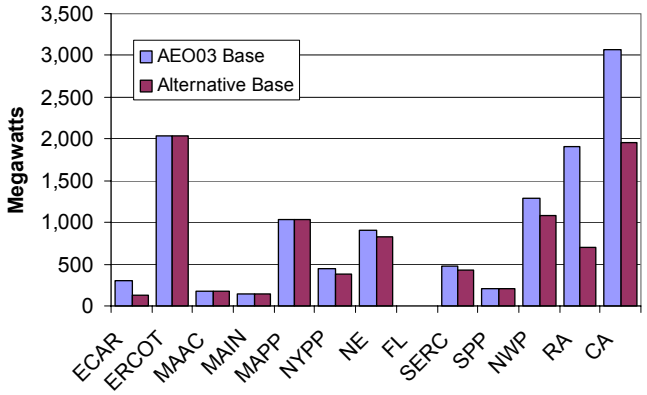
Alternative Supply Steps

- In the revised version the resource multipliers are applied by wind class, not over the entire regional resource.



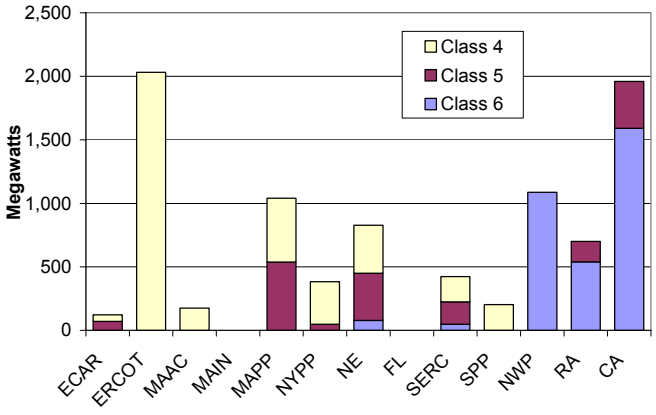
Reference Case Results 2025

- The new application of long-term multipliers is more restrictive, especially in the West.



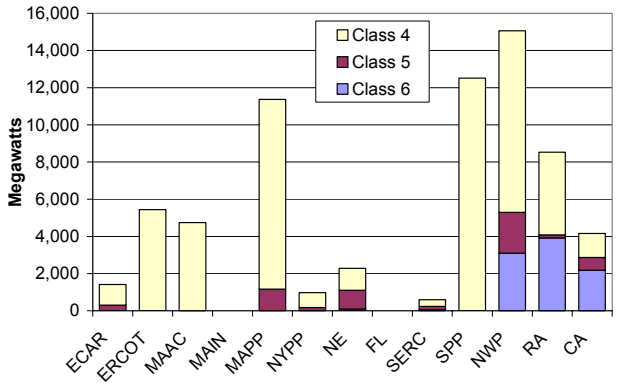
Projected Wind Capacity 2025

- In several regions, more than one wind resource is developed.



Low Wind Speed Turbine R&D Case

- When R&D impacts are included, projected capacity increases substantially, especially for Class 4.

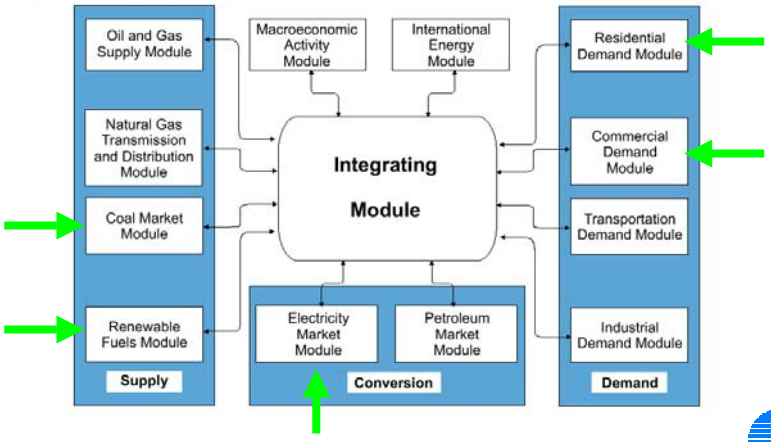


Offshore Wind

- We have also modified NEMS to include offshore wind resources
- First quick method was to increase onshore wind resource quantities at higher cost multiplier levels
  - Difficult to reflect costs correctly over time
  - Direct competition with onshore wind
- More correct method implemented where offshore wind added as another technology
  - Allows offshore wind to compete directly with all potential generation sources
  - Similar to onshore wind representation, but separate data streams
  - Production tax credits can be represented for offshore wind only or for both onshore and offshore sites.

NEMS 2050 Extension

- Only selected NEMS modules were extended, primarily those with solar technology markets.



Key NEMS Solar Modifications

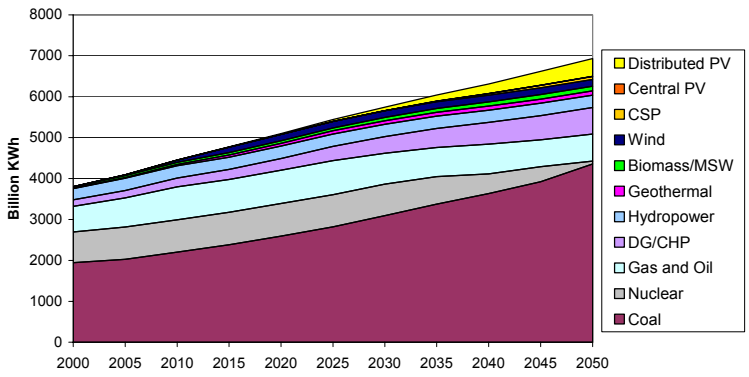
- The longer time frame and focus on solar led to several modifications of NEMS
- Distributed PV in residential and commercial buildings
  - Modified algorithm for adoption rates
    - Continuous rather than discrete functional form
    - Shift of one year in adoption rate to allow one year payback if very low cost
  - Increased average system size from 2kW to 4kW for residential and 10 kW to 100 kW for commercial, with a capability for change in capacity size over forecast period
  - Increased maximum penetration rates for single family homes and commercial buildings
  - Added PV for multi-family homes
  - Added stock accounting with retirements

Key NEMS Solar Modifications (cont.)

- Solar water heat
  - Created competition for market share in new buildings between solar and electric water heat
  - Allowed greater replacement opportunity in existing homes
- Solar space heat
  - Redefined gas heat pumps to be solar with gas back up heat
- Concentrated Solar Power (CSP)
  - Reflected EERE's R&D goals including additional storage capability
  - Increased capacity credit value

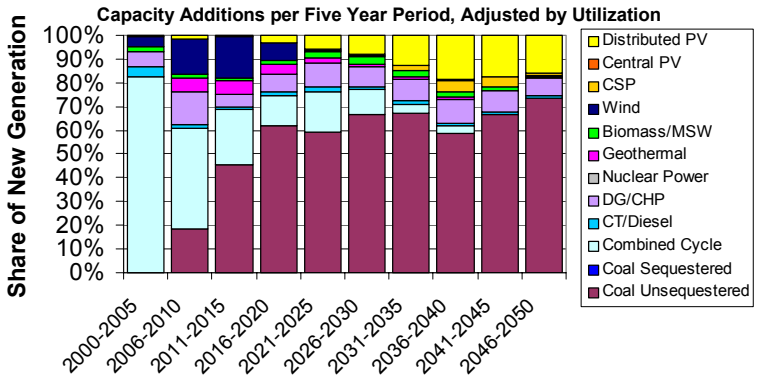
Base Case Generation

- Coal dominates future generation under the High Renewable/High Efficiency Base Case.



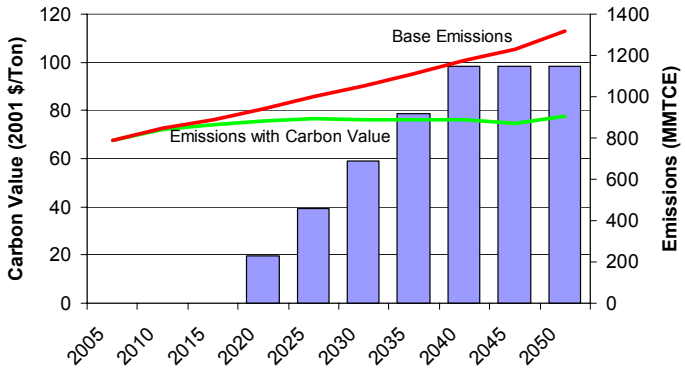
Shares of New Generation in Base

- Coal begins to dominate new additions after 2015, and distributed PV begins to enter after 2020.



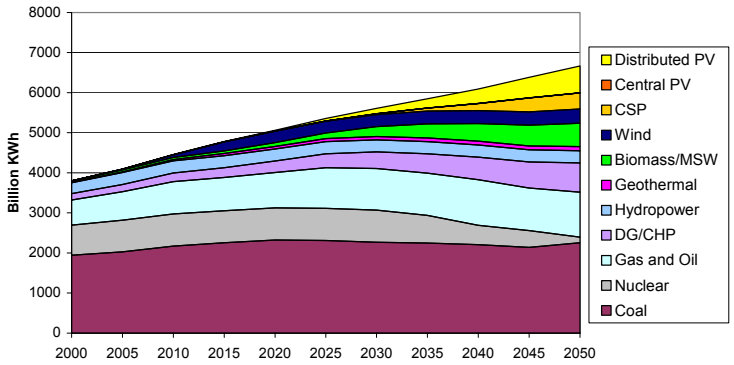
Carbon Value Case

- A case was created to roughly stabilize carbon emissions from the electricity and building sectors.



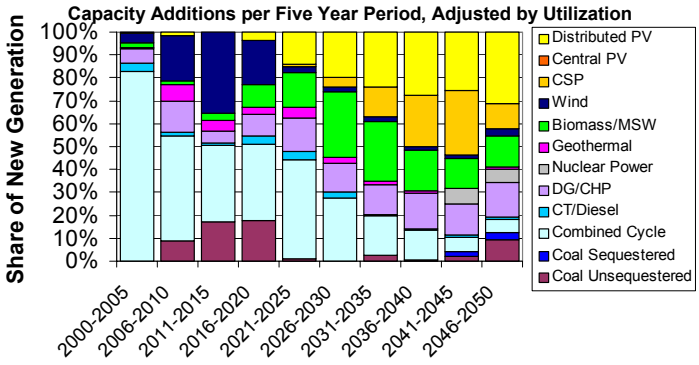
$100 Carbon Value Case

- When a value for carbon is added (ramping up from zero in 2015 to $100 in 2040), coal generation levels off and renewable generation increases substantially.



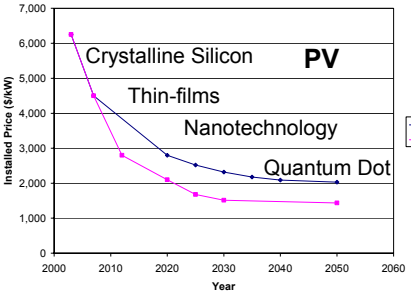
New Generation Shares with $100 Carbon

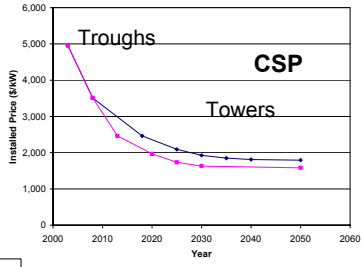
- Wind is the dominant new renewable in the early years, while solar and biomass gain additional shares as the technologies become more cost-effective.

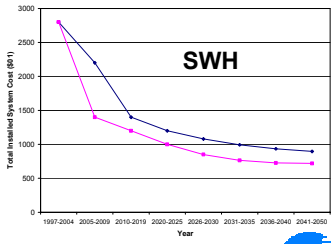


Enhanced R&D Cost Goals

- Enhanced R&D accelerates the expected decline in cost for each of the solar technologies.





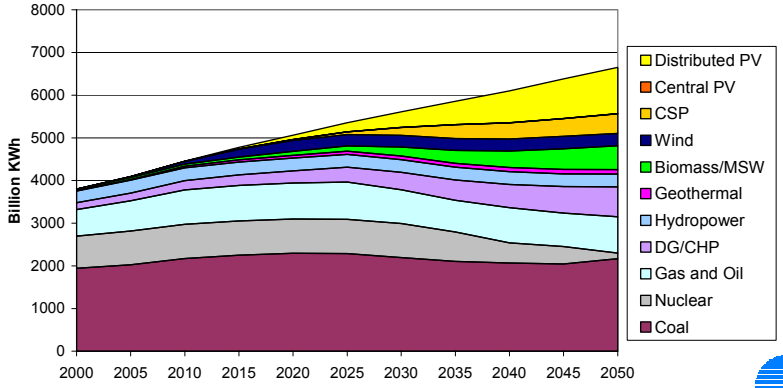


Solar Policy Case

- Central Generation Policies
  - Implement federal production tax credit (PTC) for solar: Set at 1.8 cents/kWh in 2005 (with 10-year duration), inflation adjusted through 2020, then phased out between 2020 and 2030.
  - 10% federal investment tax credit (ITC) remains in place through 2050.
  - Accelerated depreciation remains in place though 2050.
- Distributed Generation/Thermal (Residential and Commercial) Policies
  - Implement federal ITC for for distributed PV, solar water heating, and solar space heating: Set at 30% in 2005, decline linearly to 10% in 2030, and then hold at 10% through 2050.
  - Average PV system capacity increases by 50% between 2005 and 2030.

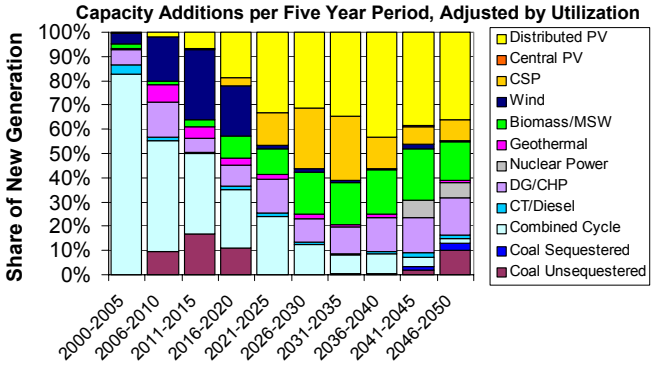
R&D and Solar Policies
Generation by Fuel

- With additional R&D and moderate policies, the solar share of generation increases to 23 percent by 2050.
- Distributed generation supplies 30 percent of demand by 2050.



R&D and Solar Policies
Shares of New Generation

- With additional R&D and moderate policies, PV and CSP begin to capture a significant share of new generation after 2020.
- After 2035, distributed generation additions are over half of the total.



NEMS Policy Analysis Capabilities

- As illustrated in these examples, NEMS can be used for analysis of
  - R&D and technology deployment policies
  - Investment and production tax credits
- NEMS can also be used for evaluating environmental policies, such as
  - SO_2, NO_x, mercury and carbon emission caps in the power sector
  - Economy-wide carbon caps or taxes
- Portfolio generation standards (renewable or other)
- Efficiency standards (CAFE, appliance)

More Information

- For more information on these analyses, visit the following web sites
  - GPRA Benefits Analysis
    http://www.eere.energy.gov/office_eere/gpra_estimates_fy05.html - especially Chapter 4
  - Wind Model Enhancements
    April 20, 2004 Renewable Energy Modeling Series
    http://www.epa.gov/cleanenergy/pdf/wood_apr20.pdf
  - NEMS 2050 Extension
    NEMS Conference March 2004
    http://www.eia.doe.gov/oiaf/aeo/conf/pdf/wood.pdf